

WHAT IS CLAIMED IS:

1. An exhaust gas purification system for an internal combustion engine, the exhaust gas purification system having a particulate filter in an exhaust passage for collecting particles included in exhaust gas and for burning and removing the particles accumulated in the particulate filter for recovering the particulate filter, the exhaust gas purification system comprising:

a pressure drop detecting unit that detects a pressure drop of the particulate filter;

a regeneration determining unit that defines an accumulation characteristic of a relationship between the accumulation amount ML of the particles and the pressure drop, wherein:

the regeneration determining unit defines a first characteristic line, which is a straight line passing an initial point in which the accumulation amount ML is zero, and a second characteristic line, which is a straight line having a smaller slope value compared with a slope of the first characteristic line;

the accumulation characteristic is defined by the first characteristic line and the second characteristic line;

the pressure drop increases along with the first characteristic line from the initial point to a predetermined increasing transitional point, and increases along with the second characteristic line from the increasing transitional point;

the regeneration determining unit calculates the accumulation amount ML based on the accumulation characteristic and an operating condition of the internal combustion engine which includes at least the pressure drop; and

the regeneration determining unit determines whether the accumulation amount ML exceeds a predetermined regeneration-starting amount ML_{th} for determining whether the regeneration of the particulate filter needs to be performed;

a exhaust particle detecting unit that detects a combusting condition of the particles accumulated in the particulate filter; and

a correcting unit that corrects the accumulation characteristic so that the second characteristic line is substantially parallelly shifted to a direction, in which the accumulation amount ML becomes large when the particles are in the combusting condition.

2. The exhaust gas purification system according to claim 1, further comprising:

a exhaust particle integrating unit that integrates a decreasing amount of the accumulation amount ML of the particles, that is burned before the regeneration of the particulate filter due to high temperature exhaust gas and partially burned due to termination (interruption) of a previous regeneration, for calculating an integrated combustion amount IML_{comb} , wherein

the correcting unit performs correcting such that a shifting amount of the second characteristic line becomes large as the integrated combustion amount IMLcomb increases so that the accumulation amount ML becomes larger with respect to the same pressure drop.

3. The exhaust gas purification system according to claim 1, wherein the corrected second characteristic line passes the initial point when the correcting unit sets a maximum shifting amount to the second characteristic line.

4. An exhaust gas purification system for an internal combustion engine, the exhaust gas purification system having a particulate filter in an exhaust passage for collecting particles included in exhaust gas, and for burning and removing the particles accumulated in the particulate filter for recovering the particulate filter, the exhaust gas purification system comprising:

a pressure drop detecting unit that detects a pressure drop of the particulate filter;

a regeneration determining unit that defines an accumulation characteristic of a relationship between an accumulation amount ML of the particles and the pressure drop, wherein:

the regeneration determining unit has an increase characteristic line, which is protruded to a direction where the pressure drop becomes large and passing an initial point,

and a decrease characteristic line protruded to a direction where the pressure drop becomes small;

the accumulation characteristic is defined by the increase characteristic line and the decrease characteristic line;

the pressure drop increases along with the increase characteristic line from the initial point, and decreases along with the decrease characteristic line to the initial point;

the regeneration determining unit calculates the accumulation amount ML based on the accumulation characteristic and an operating condition of the internal combustion engine which includes at least the pressure drop; and

the regeneration determining unit determines whether the accumulation amount exceeds a predetermined regeneration-starting amount for determining whether the regeneration of the particulate filter needs to be performed; and

an exhaust particle detecting unit that detects a burning condition of the particles accumulated in the particulate filter, wherein

the regeneration determining unit calculates the accumulation amount ML based on the increase characteristic when the particles are in a non-combusting condition, and calculates the accumulation amount ML based on the decrease characteristic when the particles are in the combusting condition.

5. The exhaust gas purification system according to claim 4, wherein

the regeneration determining unit calculates the accumulation amount ML based on the slope of the decreasing characteristic line passing the pressure drop and the accumulation amount at a time point when a condition of the particles changes from the non-combusting condition to the combusting condition; and

the regeneration determining unit calculates the accumulation amount ML based on the slope of the increasing characteristic line passing the pressure drop and the accumulation amount at a time point when the condition of the particles changes from the combusting condition to the non-combusting condition.

6. The exhaust gas purification system according to claim 4, wherein

the increase characteristic is defined by a first increase characteristic line, which is a straight line passing the initial point, and a second increase characteristic line, which is a straight line passing an increasing transitional point and having a smaller slope value compared with a slope of the first increase characteristic line; and

the pressure drop increases along with the first increase characteristic line from the initial point to the increasing transitional point, and increases along with the

second increase characteristic line from the increasing transitional point.

7. The exhaust gas purification system according to claim 4, wherein

the decreasing characteristic is defined by a first decrease characteristic line, which is a straight line passing the pressure drop and the accumulation amount at a point in time, and a second decrease characteristic line, which is a straight line passing a decreasing transitional point and having a lower slope value compared with a slope of the first decrease characteristic line; and

the pressure drop decreases along with the first decrease characteristic line to the decreasing transitional point, and decreases along with the second decrease characteristic line from the decrease transitional point to the initial point.

8. The exhaust gas purification system according to claim 4, wherein

the increasing characteristic is defined by a first increase characteristic line, which is a straight line passing the initial point, and a second increase characteristic line, which is a straight line passing an increasing transitional point and having a lower slope value compared with a slope of the first increase characteristic line;

the decrease characteristic is defined by a first

decrease characteristic line, which is a straight line passing the pressure drop and the accumulation amount at the moment, and a second decrease characteristic line, which is a straight line passing an decreasing transitional point and having a gentler slope compared with a slope of the first decrease characteristic line;

the pressure drop increases along with the first increase characteristic line from the initial point to the increasing transitional point, and increases along with the second increase characteristic line from the increase transitional point;

the pressure drop decreases along with the first decrease characteristic line to the decreasing transitional point, and decreases along with the second decrease characteristic line from the decrease transitional point to the initial point; and

at least one relationship between the first increase characteristic line and the first decrease characteristic line, and between the second increase characteristic line and the second decrease characteristic line, is represented by substantially parallel lines.

9. The exhaust gas purification system according to claim 7, wherein

the regeneration determining unit calculates the accumulation amount ML based on the first decrease characteristic line passing the pressure drop and the

accumulation amount at the moment, when the condition of the particles changes from the combusting condition to the non-combusting condition.

10. The exhaust gas purification system according to claim 9, further comprising:

a exhaust particle integrating unit that integrates a decreasing amount of the accumulation amount ML of the particles, that is burned due to high temperature exhaust gas before the regeneration of the particulate filter and partially burned due to an interruption in a previous regeneration, to calculate an integrated combustion amount IML_{comb} ,

wherein the regeneration determining unit sets the second decrease characteristic line when the integrated combustion amount IML_{comb} becomes equal to or greater than a predetermined amount.

11. The exhaust gas purification system according to claim 2, wherein

the exhaust particle integrating unit includes a first calculating unit that calculates a decreasing amount of the accumulation amount based on a decreasing amount of the pressure drop, and calculates an exhaust amount PM_{out} based on an operating condition of the internal combustion engine, and calculates the decreasing amount of the accumulation amount ML by adding the decreasing amount of the accumulation amount to

the PM-exhaust amount PMout and a second calculating unit calculates the decreasing amount of the accumulation amount based on a temperature of the particulate filter;

an operating condition determining unit determines whether the internal combustion engine is in a steady operating condition or not; and

an updating unit that calculates the integrated combustion amount IMLcomb based on the decreasing amount of the accumulation amount ML calculated in the first calculating unit when a positive determination is made in the operating condition determining unit, and calculates the integrated combustion amount IMLcomb based on the decreasing amount of the accumulation amount ML calculated in the second calculating unit when a negative determination is made in the operating condition determining unit.

12. The exhaust gas purification system according to claim 11, wherein

the operating condition determining unit estimates the temperature distribution of the particulate filter, and determines if an operating condition is in a steady condition when a temperature distribution of the particulate filter is substantially uniform.